US005809520A

United States Patent [19]

Edwards et al.

[11] **Patent Number: 5,809,520**

[45] **Date of Patent: Sep. 15, 1998**

[54] **INTERCHANGEABLE CARTRIDGE DATA STORAGE SYSTEM FOR DEVICES PERFORMING DIVERSE FUNCTIONS**

[75] Inventors: **Kim B. Edwards**, Layton, Utah; **George T. Krieger**, Carmel, Calif.; **Fred Thomas, III**, Ogden; **Brent J. Watson**, Bountiful, both of Utah

[73] Assignee: **Iomega Corporation**, Roy, Utah

[21] Appl. No.: **746,085**

[22] Filed: **Nov. 6, 1996**

[51] **Int. Cl.**^{6} **G06K 7/00**; G06F 12/06; G11B 23/00

[52] **U.S. Cl.** **711/115**; 711/2; 711/5; 395/833; 360/133; 360/135; 360/97.01; 369/15; 369/231; 463/94; 463/45; 396/211; 396/321; 348/233

[58] **Field of Search** 711/2, 5, 115; 395/833; 369/15, 85, 231; 379/100.02; 396/211, 321; 365/230.03; 360/133, 135, 97.01; 439/946; 463/44, 45; 83/761; 112/457; 345/901; 348/233

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,553,175	11/1985	Baumeister .	
4,570,188	2/1986	Ichiyanagi .	
4,797,761	1/1989	Cocco .	
4,803,576	2/1989	Ohkita et al. .	
5,034,804	7/1991	Sasaki et al. .	
5,055,950	10/1991	Kimura et al. .	
5,132,947	7/1992	Kameda et al.	369/32
5,161,770	11/1992	Morehouse et al. .	
5,214,550	5/1993	Chan	360/97.01
5,297,067	3/1994	Blackborow et al.	364/708.1
5,408,374	4/1995	Morehouse et al. .	
5,420,750	5/1995	Freige et al.	361/695
5,426,562	6/1995	Morehouse et al. .	
5,434,618	7/1995	Hayashi et al. .	
5,442,266	8/1995	Morehouse et al. .	
5,448,433	9/1995	Morehouse et al. .	
5,469,314	11/1995	Morehouse et al. .	
5,486,964	1/1996	Morehouse et al. .	
5,508,864	4/1996	Briggs et al. .	
5,530,607	6/1996	Spendlove .	
5,701,894	12/1997	Cherry et al.	128/904

FOREIGN PATENT DOCUMENTS

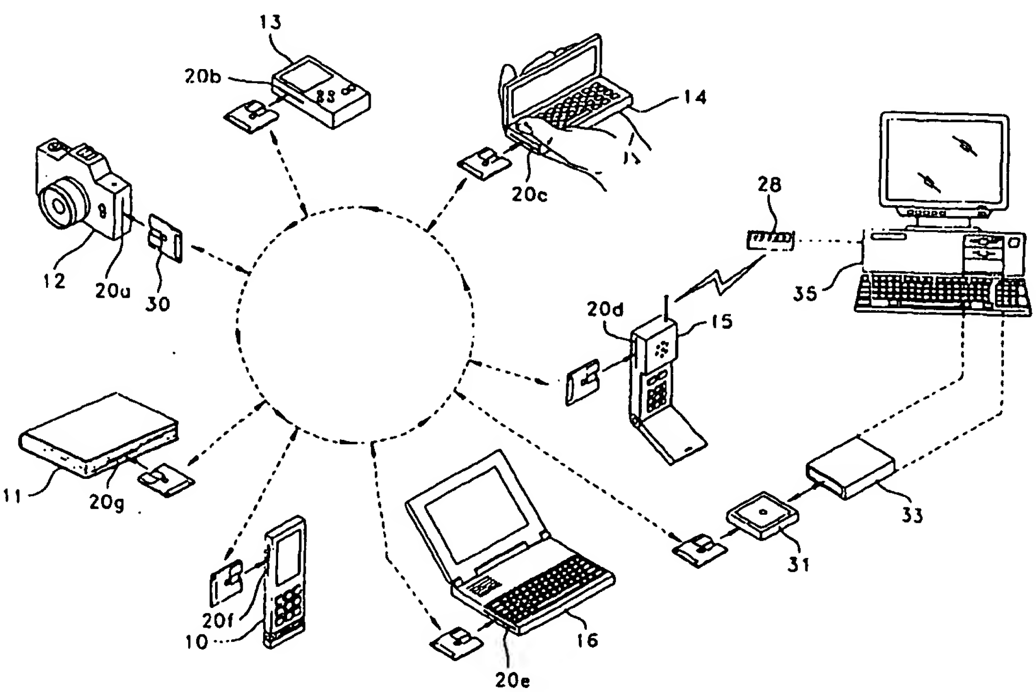
2 594 997	8/1987	France .

Primary Examiner—Tod R. Swann
Assistant Examiner—J. Peikari
Attorney, Agent, or Firm—Woodcock Washburn Kurtz Mackiewicz & Norris LLP

[57] **ABSTRACT**

A system for exchanging digital data among a plurality of hand-held computer devices. Digital signals are written by a first hand-held device to a mini-cartridge that mini-cartridge is inter-operable among a class of hand-held devices, each of which is equipped with a mini-disk drive. A common digital data format is employed to further facilitate exchange of data between devices.

9 Claims, 17 Drawing Sheets



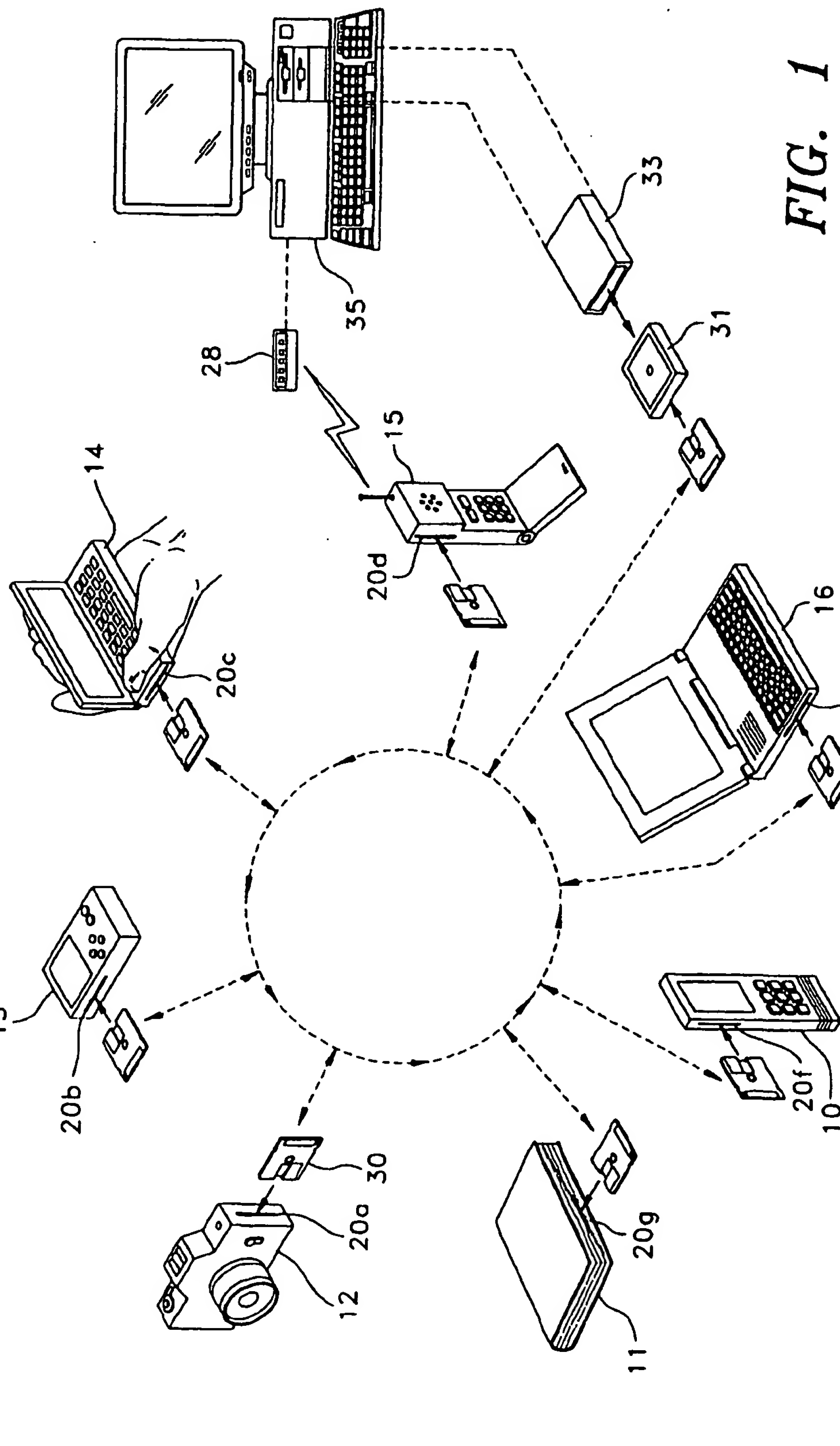


FIG. 1

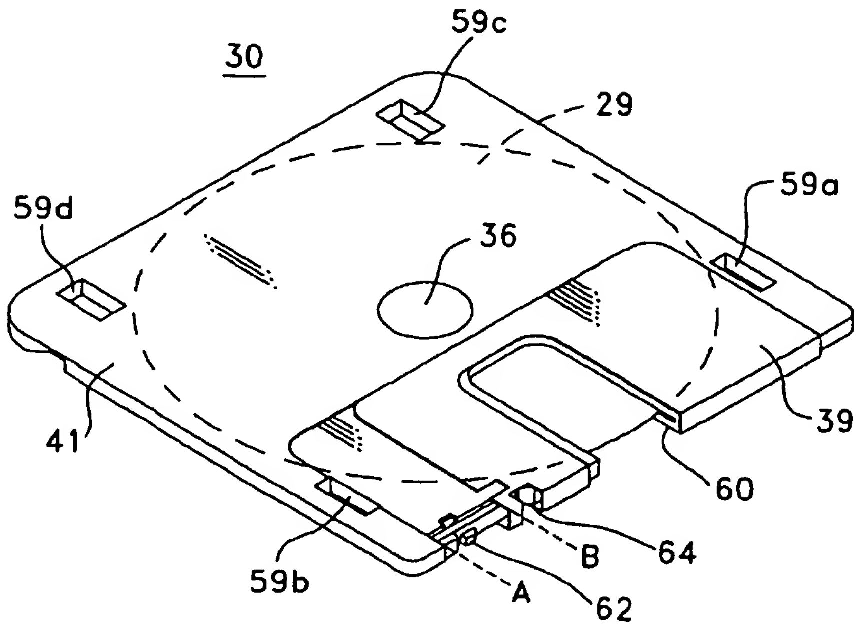

59c
30
29
59a
59d
36
39
41
60
64
B
59b
A
62

FIG. 2A

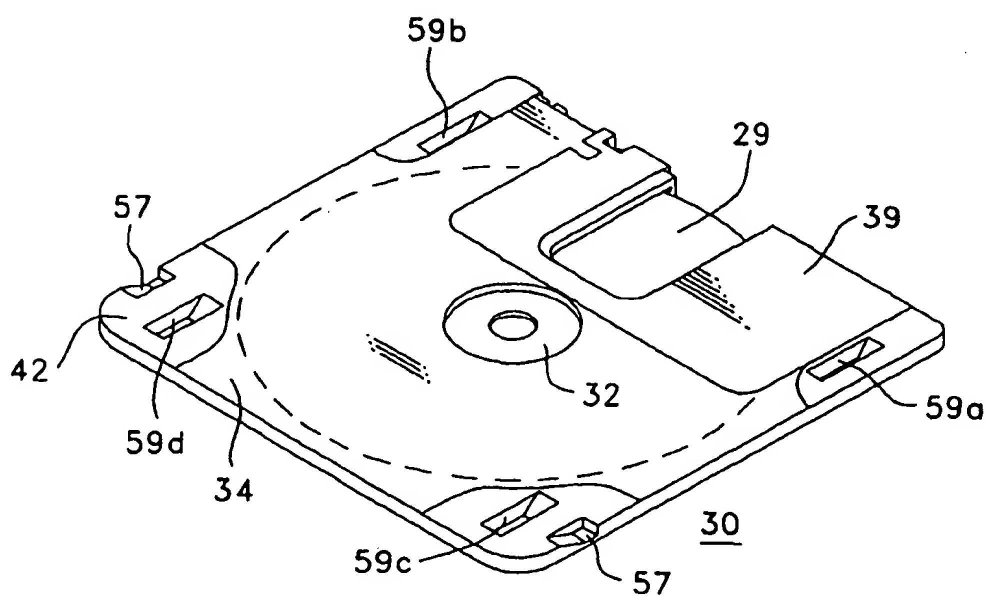

59b
29
57
39
42
32
59a
59d
34
30
59c
57

FIG. 2B

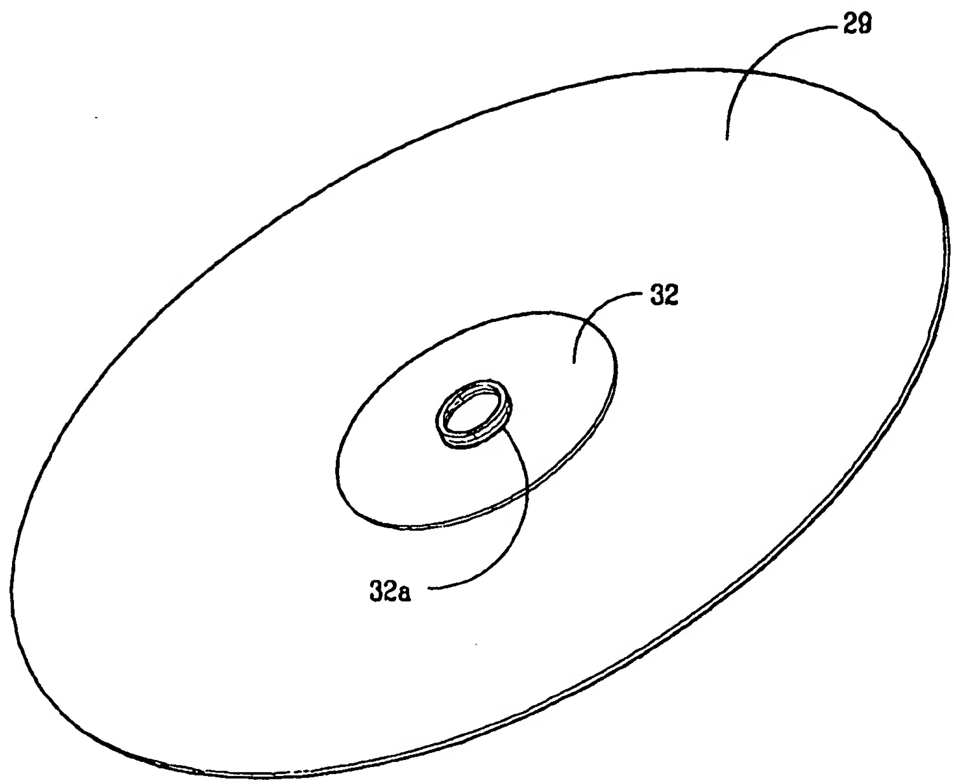
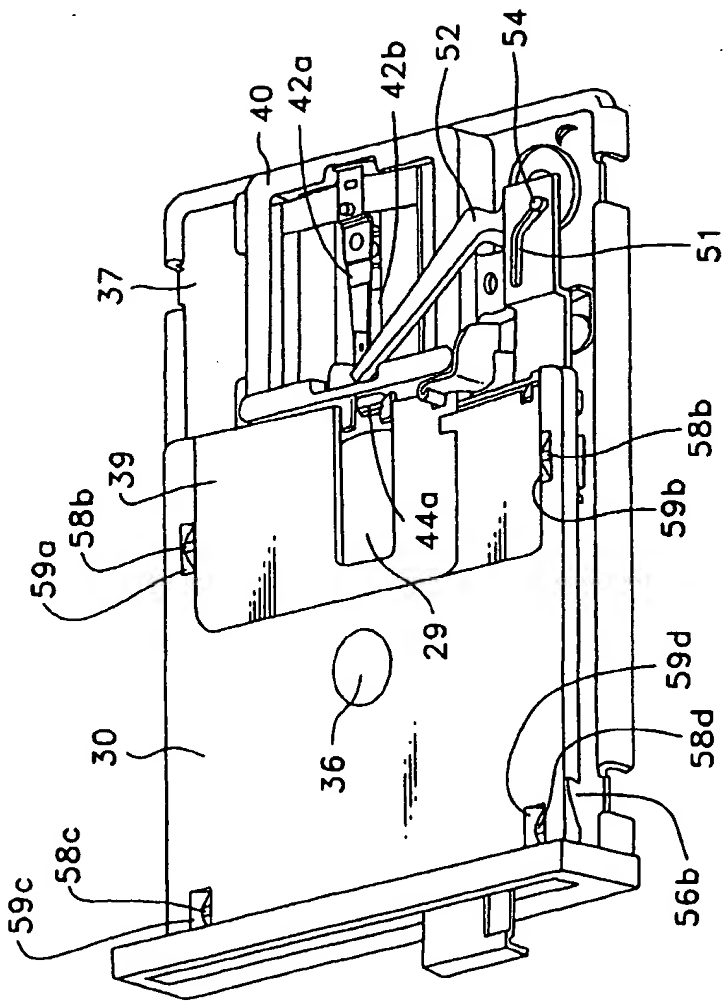


FIG. 2C



40
42a
42b
52
54
37
51
39
58b
59a
58b
44a
59b
29
30
36
59d
58d
58c
59c
56b

FIG. 3A

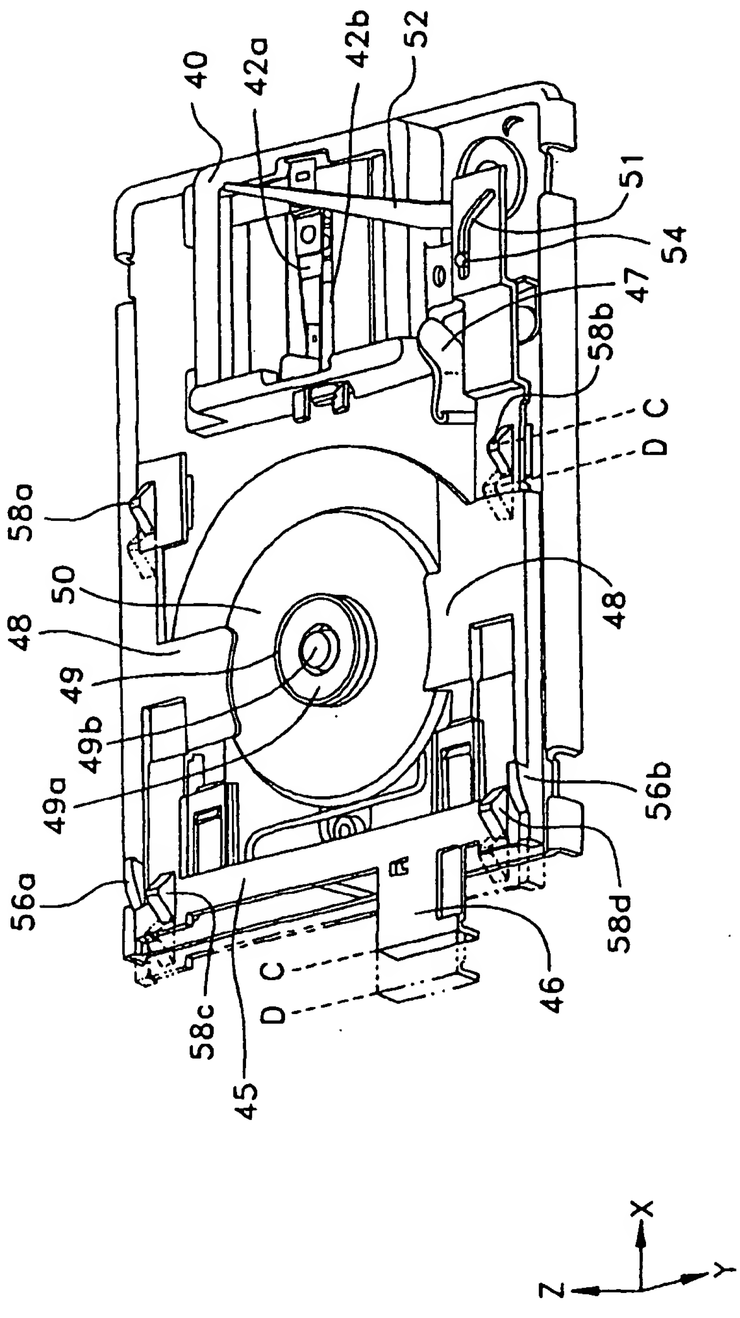
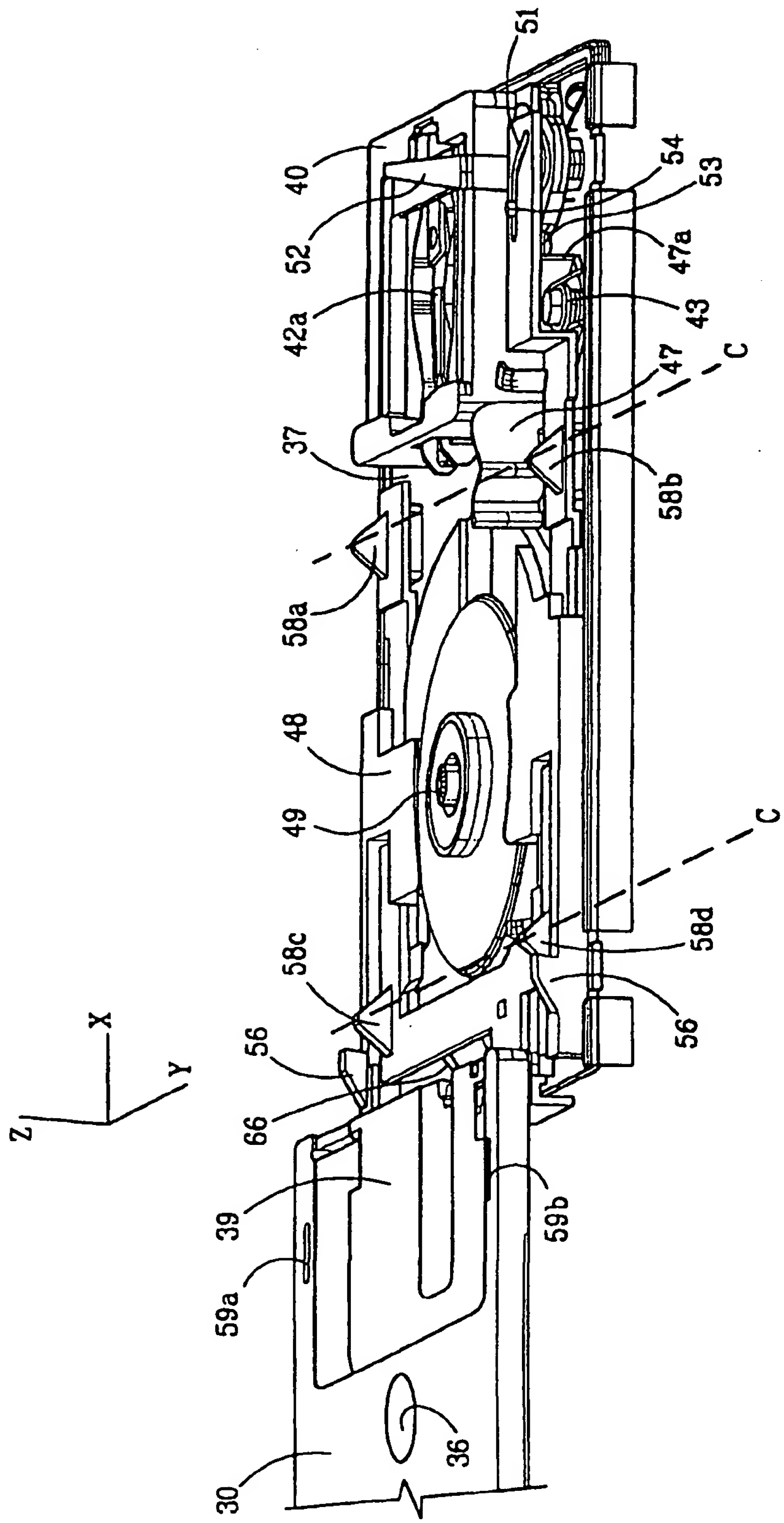

40
42a
42b
52
51
54
47
58b
C
D
58a
50
48
49
49b
49a
56a
58c
45
C
D
46
58d
56b
48
X
Y
Z

FIG. 3B



51
40
54
53
52
47a
42a
43
47
C
37
58b
58a
48
49
C
58d
58c
56
56
X
Y
Z
66
39
59b
59a
36
30

FIG. 4A

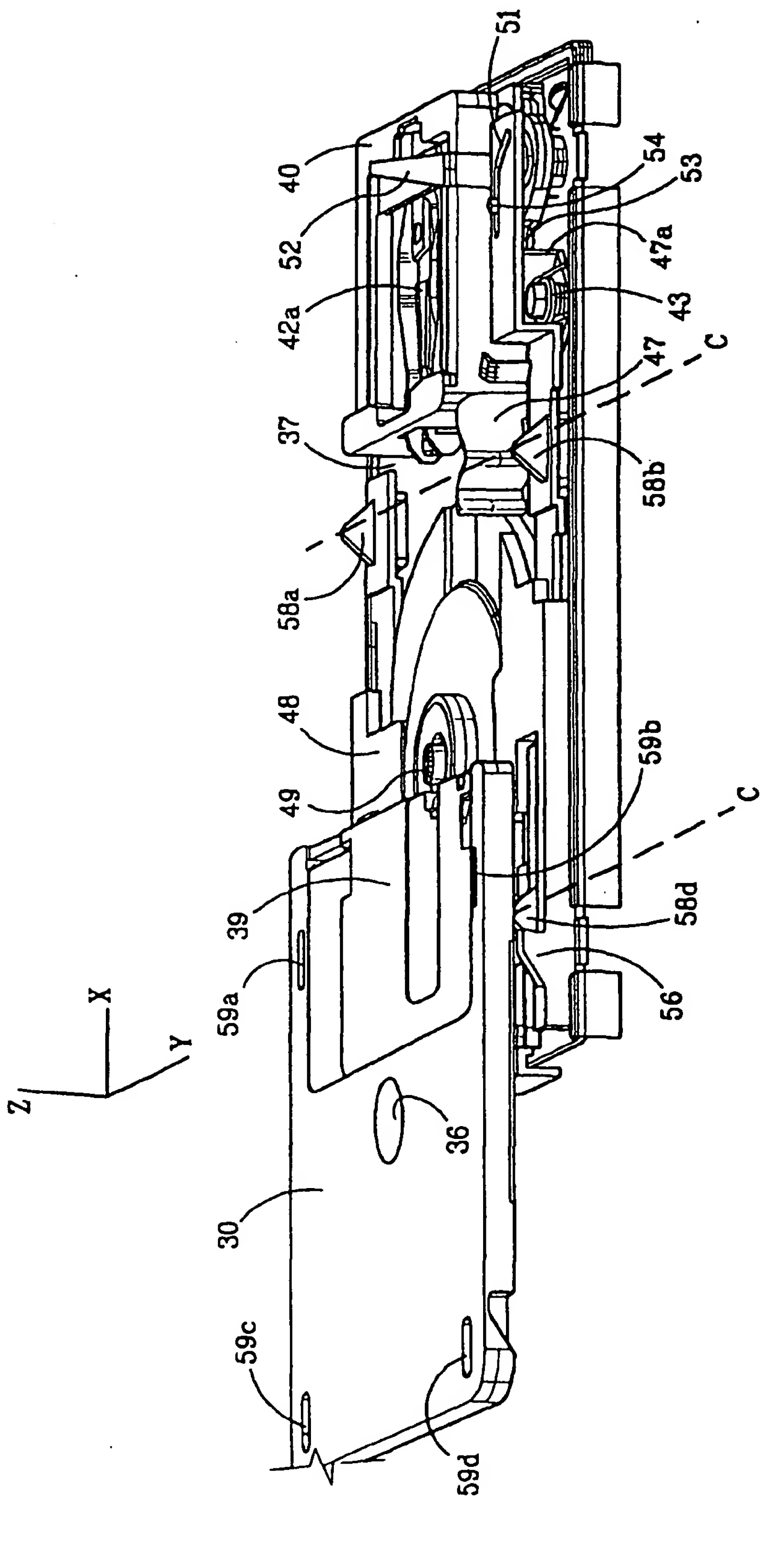

51
40
54
53
52
47a
42a
43
47
C
37
58b
58a
48
59b
49
C
39
58d
59a
56
X
Y
Z
36
30
59c
59d

FIG. 4B

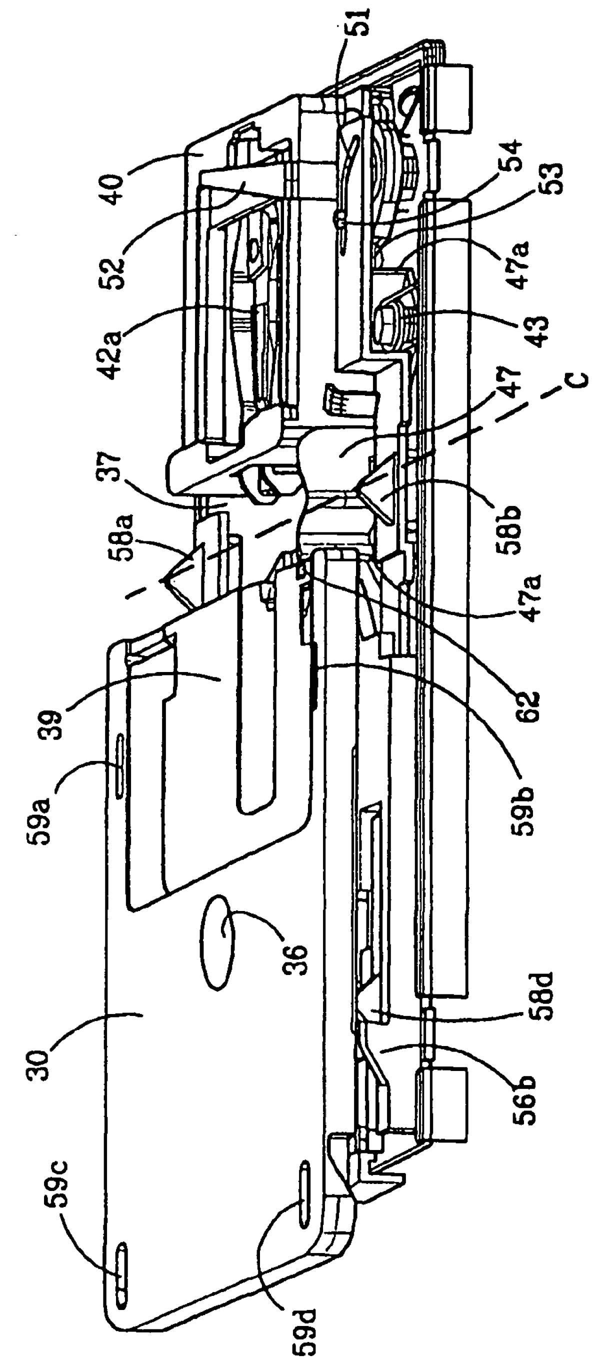

51
40
54
53
52
47a
42a
43
47
C
37
58b
58a
47a
39
62
59a
59b
36
30
58d
56b
59c
59d

FIG. 4C

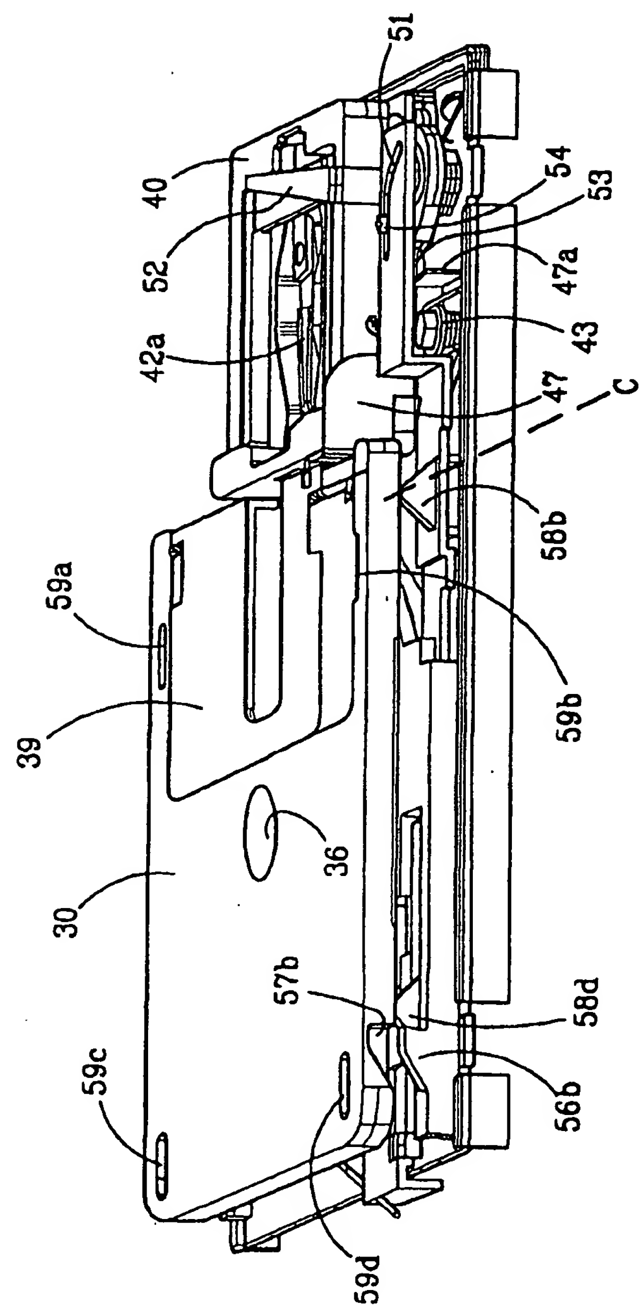

51
40
54
53
52
47a
42a
43
47
C
58b
59a
39
59b
36
30
57b
58d
59c
56b
59d

FIG. 4D

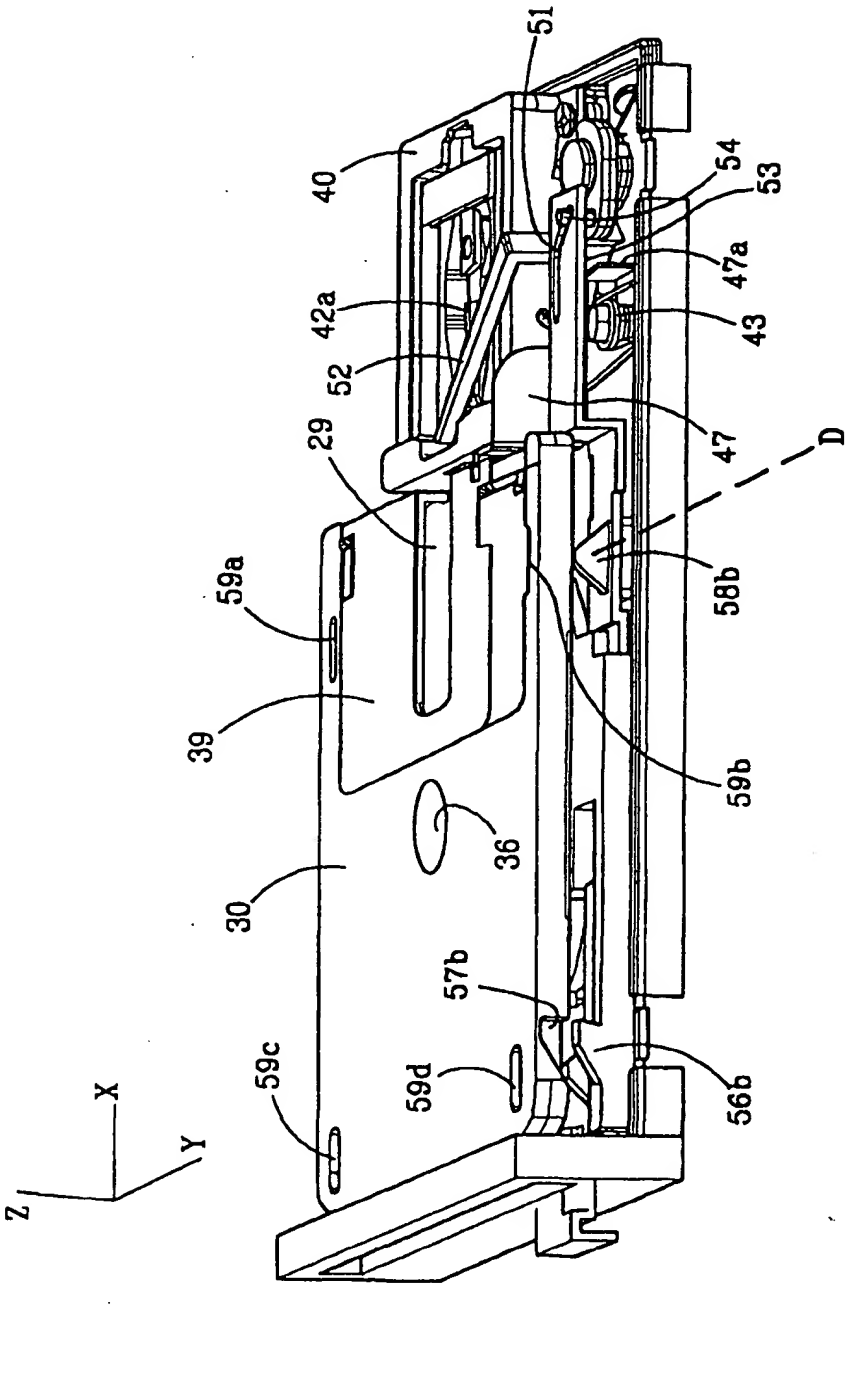

51
40
54
53
47a
42a
43
52
47
29
D
59a
58b
39
59b
36
30
57b
59c
59d
56b
X
Y
Z

FIG. 4E

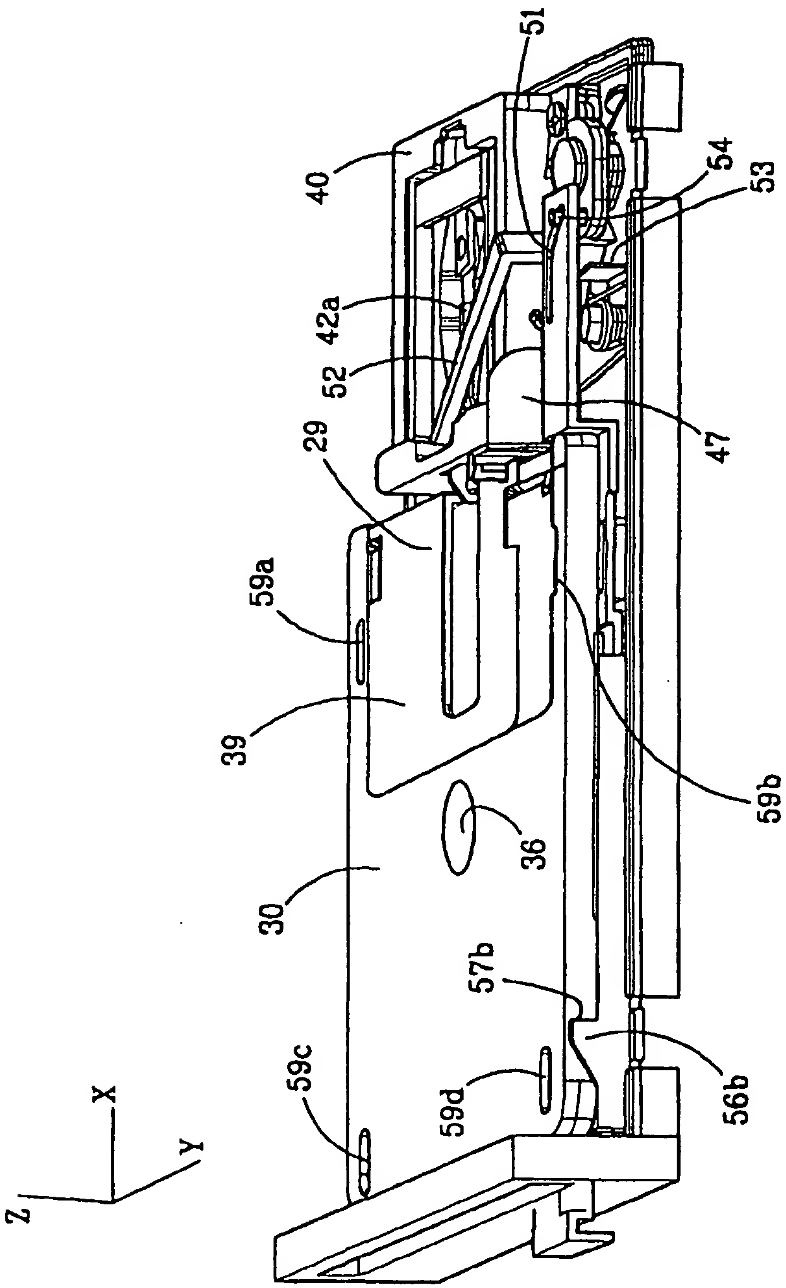


FIG. 4F

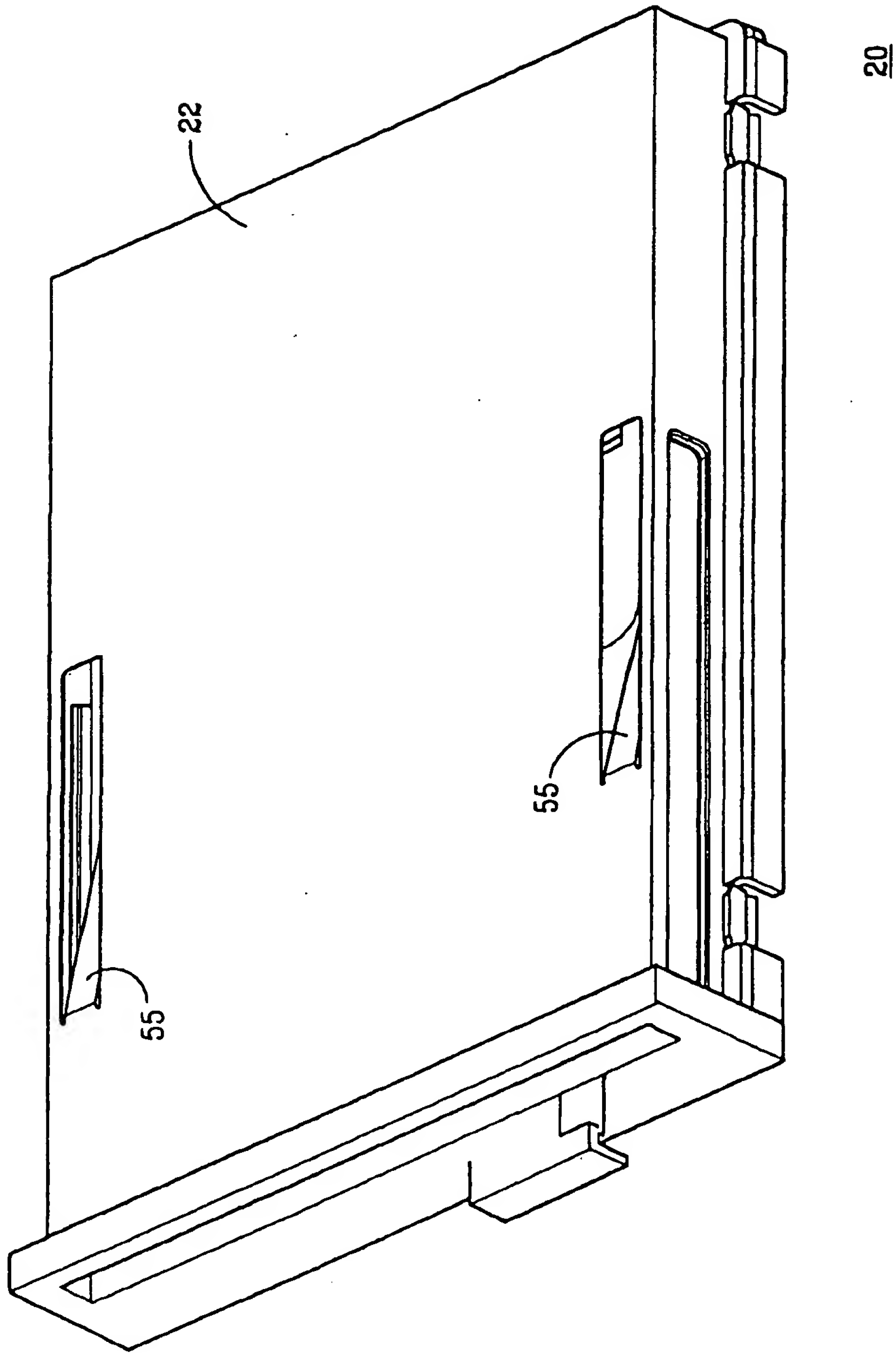


FIG. 5

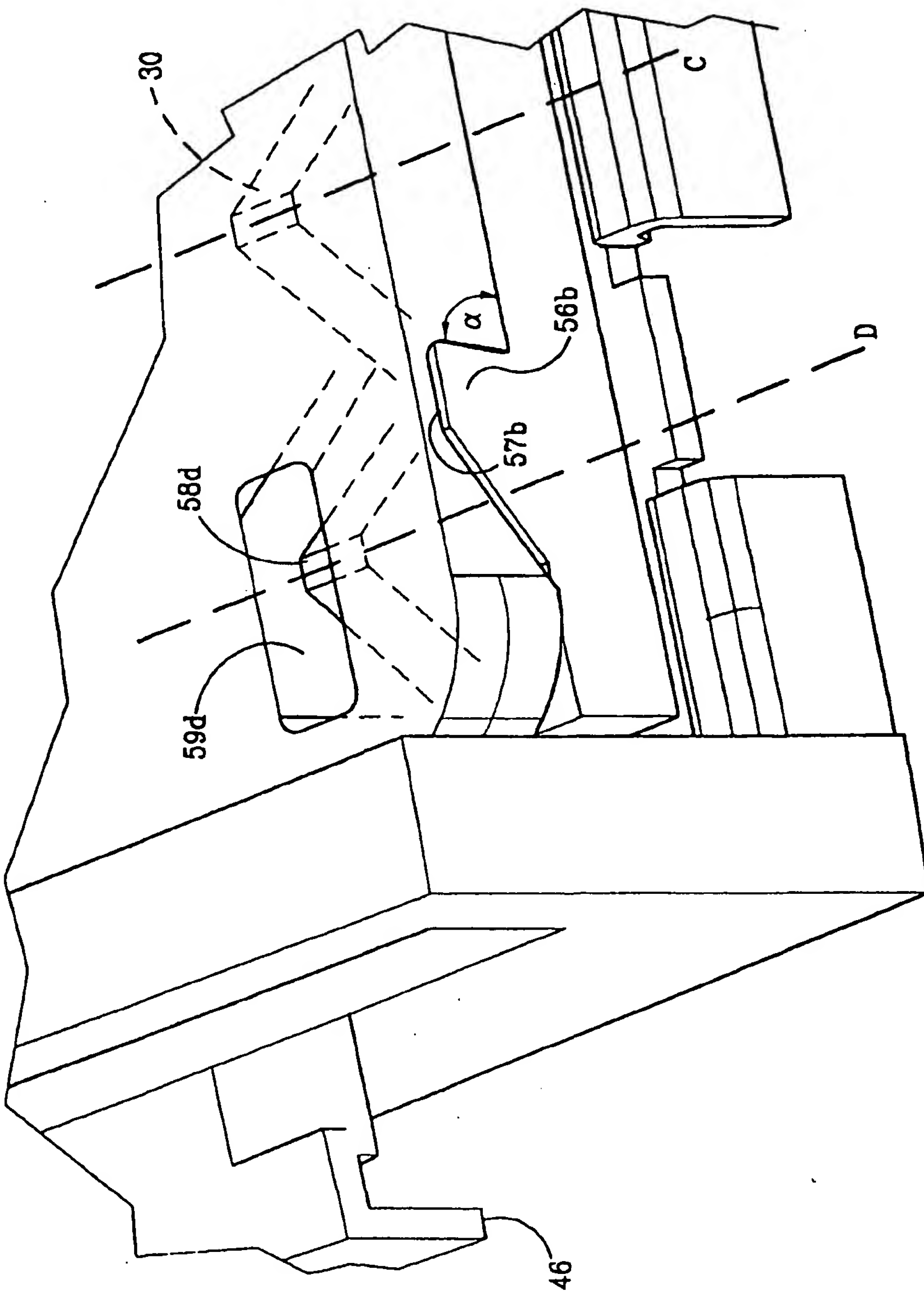
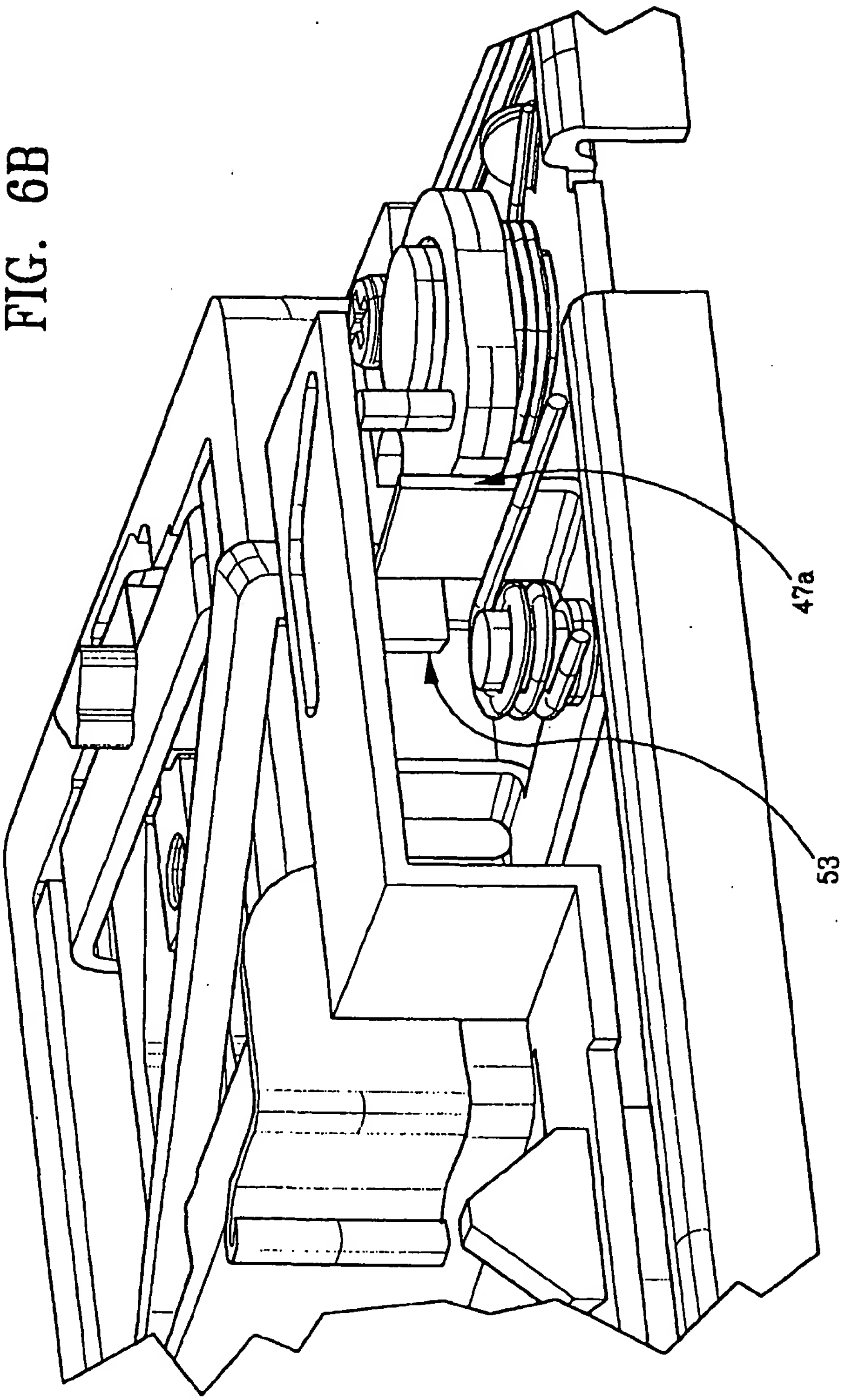


FIG. 6A

FIG. 6B



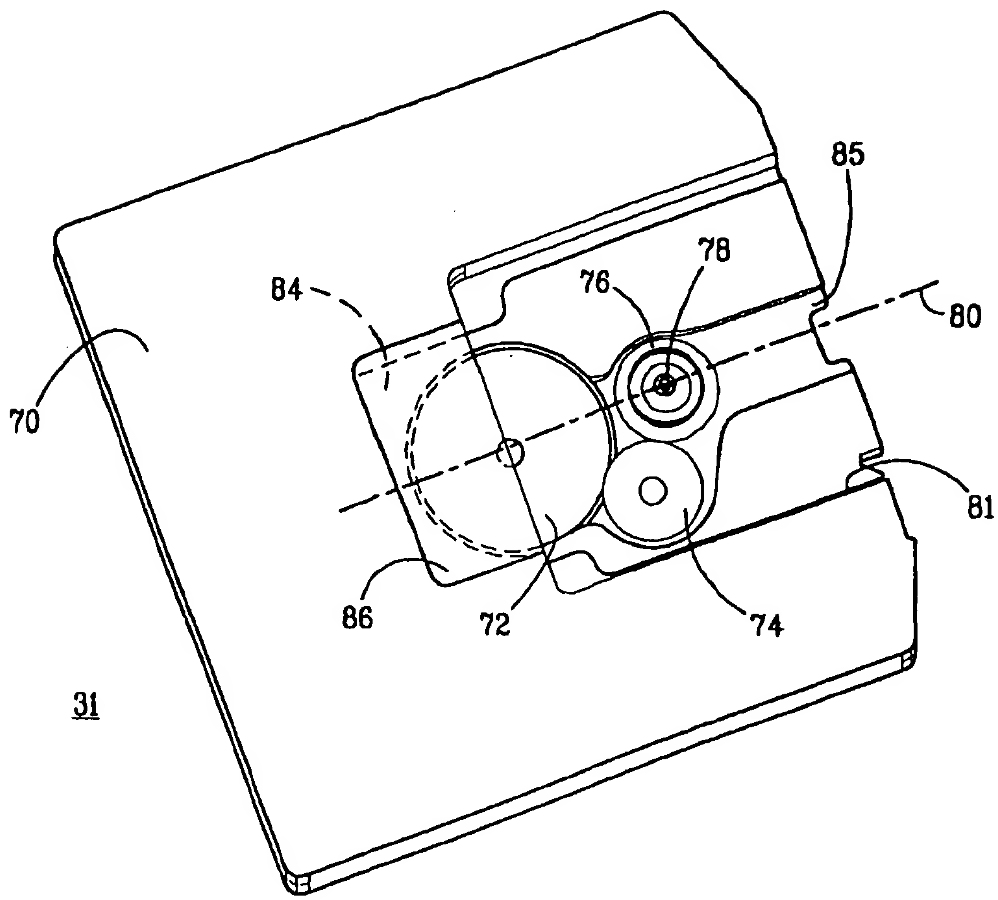


FIG. 7A

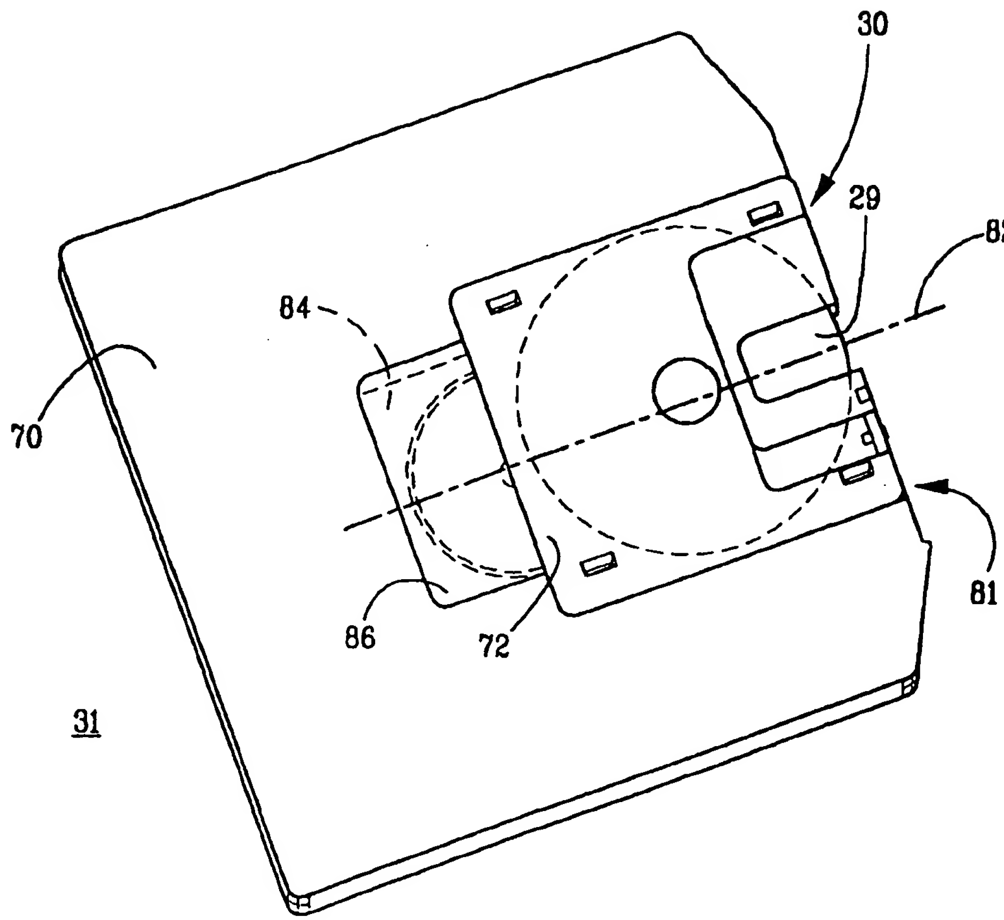
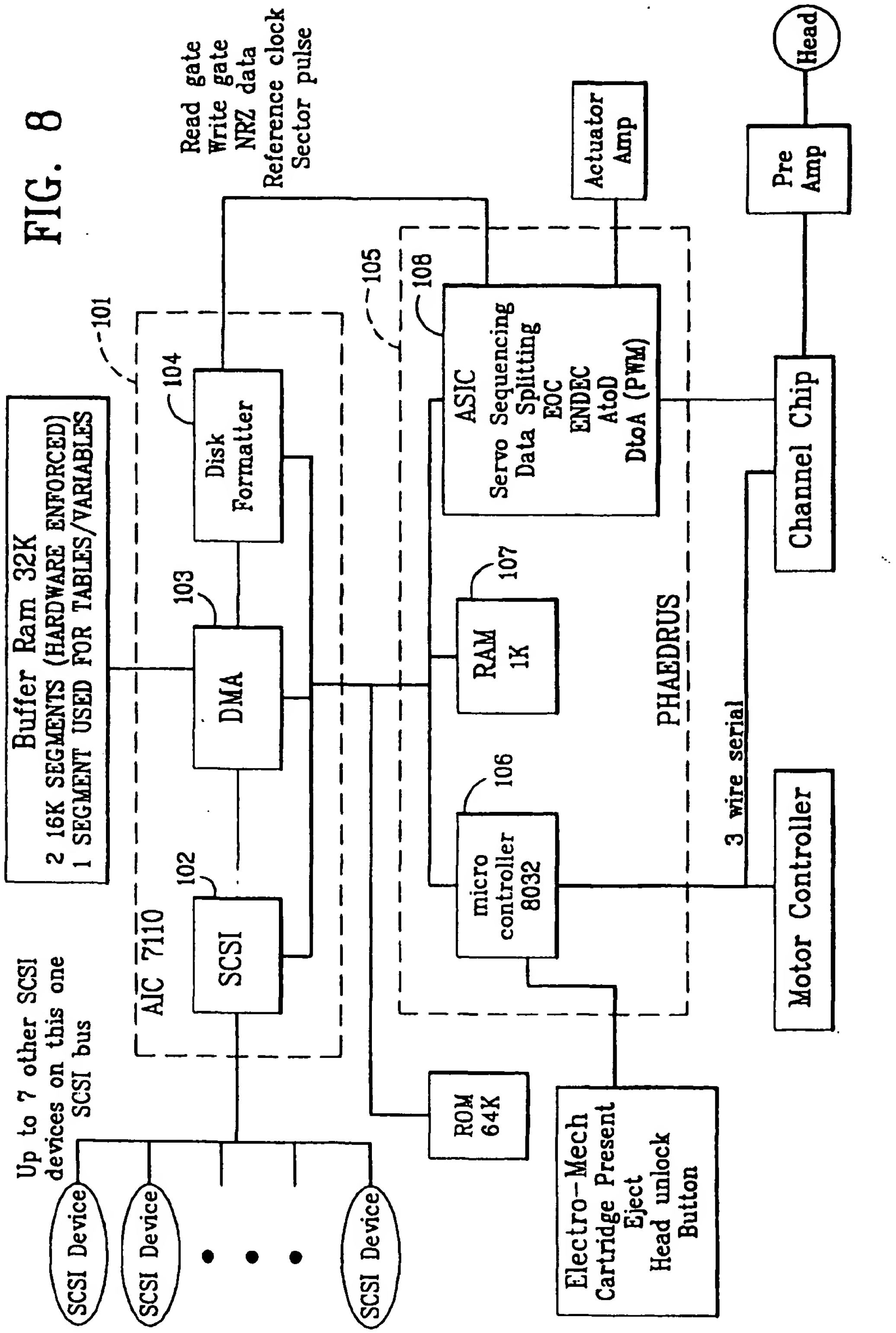


FIG. 7B

FIG. 8


Read gate
Write gate
NRZ data
Reference clock
Sector pulse
Actuator Amp
Head
Pre Amp
101
104
105
108
Disk Formatter
ASIC
Servo Sequencing
Data Splitting
EOC
ENDEC
AtoD
DtoA (PWM)
Channel Chip
Buffer Ram 32K
2 16K SEGMENTS (HARDWARE ENFORCED)
1 SEGMENT USED FOR TABLES/VARIABLES
103
DMA
107
RAM 1K
PHAEDRUS
3 wire serial
106
micro controller 8032
Motor Controller
102
SCSI
AIC 7110
Up to 7 other SCSI devices on this one SCSI bus
ROM 64K
Electro-Mech
Cartridge Present
Eject
Head unlock
Button
SCSI Device
SCSI Device
SCSI Device

INTERCHANGEABLE CARTRIDGE DATA STORAGE SYSTEM FOR DEVICES PERFORMING DIVERSE FUNCTIONS

BACKGROUND OF THE INVENTION

This invention relates to an interchangeable cartridge data storage system and more particularly to a storage system in which a mini-cartridge is compatible with devices generating signals representing different functions and the mini-cartridge is compatible, by use of a caddy, with a full size drive which can transfer signals between that drive and a host computer.

Microprocessors and supporting computer technologies are rapidly increasing in speed and computing power while decreasing in cost and size. These factors have led to the broad application of microprocessors to an array of electronic products, such as hand-held computers, digital cameras, cellular phones and the like. All of these devices have, in effect, become computers with particular application-specific attributes. For this new breed of computer products, enormous flexibility is gained by the ability to exchange data files and store computer software.

A variety of proprietary storage devices have been used in computer products. For example, hand-held computers have used integrated circuit memory cards ("memory cards") as the primary information storage media. Memory cards include memory storage elements, such as static random access memory (SRAM), or programmable and erasable non-volatile memory, such as "flash" memory. Memory cards each are typically the size of a conventional credit card and are used in portable computers in place of hard disk drives and floppy disk drives. Furthermore, memory cards enhance the significant advantages of the size, weight, and battery lifetime attributes of the portable computer and increase portability of the storage media. However, because of the limited memory density attainable in each memory card and the high cost of the specialized memory chips, using memory cards in hand-held computers imposes limitations not encountered in less portable computers, which typically use more power-consuming and heavier hard and floppy disk drives as their primary storage media.

Other of these computer products, such as the digital camera, have employed miniature video disks as the storage media. For example, U.S. Pat. No. 4,553,175 issued Nov. 12, 1985 to Baumeister discloses a digital camera configured to store information on a magnetic disk. In Baumeister, a signal processor receives signals representative of a picture from a photo sensor. Those signals are recorded on a magnetic disk for later processing. Unfortunately, the video disk storage product provides limited storage capacity. For that and other reasons (e.g., power consumption and cost), the video disk has not been used in other computer products. As a result, interchanging data from one of these digital cameras with other computer products, such as a hand-held computer, is not readily achieved.

Miniature hard disk drives have also been suggested for use in portable computer products. For example, U.S. Pat. No. 5,469,314 issued Nov. 21, 1995 to Morehouse et al. discloses a miniature hard drive for use in portable computer applications. In Morehouse, a hard disk drive is described that is approximately 50 mm in diameter. While addressing many of the problems presented by storage requirements in portable computers, the obvious problem of removability of the storage media is still present.

Thus, Applicants have recognized that there is a long-felt need for a storage media that has adequate storage capacity and that addresses the need for reduced size and interchangeability across a multitude of computer products.

SUMMARY OF THE INVENTION

In accordance with the present invention a mini-cartridge is provided for mini drives in a plurality of hand-held devices which generate signals representing different functions performed by different classes of the devices. For example, the devices include digital cameras, electronic books, global positioning systems, personal digital systems, portable games and cellular phones. Each of these devices has a mini drive for writing signals and reading signals representing the functions to and from a magnetic medium in the mini-cartridge. In this way, signals representing the diverse functions performed by the different classes of devices are recorded on the mini-cartridge. The hand-held devices incorporating the present invention provide and create a single means of capturing, moving and storing information across multiple products.

The mini-cartridge can be inserted into the mini drive of other devices. For example, a reporter could snap a photograph with a digital camera having a mini drive of the present invention, use a mini drive to save and transport the image to a mini drive equipped cell phone and then transmit the image to a news bureau, anywhere in the world.

The mini-cartridge from that cell phone can then be operated upon by a personal computer. Further by way of example, the mini-cartridge can be inserted into a caddy which accommodates the mini-cartridge to make it compatible with a full-size disk drive. The ZIP drive, marketed by Iomega Corporation, is typical of a full-size drive which can read the mini-cartridge because the caddy, in which the cartridge is inserted, makes it compatible with the full-size drive.

Full-size drives, such as the ZIP drive, are commonly included in personal computer systems. The full-size drive makes the signals recorded on a mini-cartridge readable. These signals are transmitted through the input/output channel and interface to a host computer which operates on the signals in the same manner as any other magnetically recorded signals.

As further example of the uses and advantages of the present invention, the mini-cartridge can be used in digital cameras similar to the way film is used in a traditional camera, capturing up to 70–80 images on a single disk at a low cost per disk. Currently, consumers must pay hundreds of dollars for a flash memory card holding the same number of images.

The mini drive and cartridge can be used to quickly transfer a phone number list from a PDA to a cell phone, or save a fax on a mini-cartridge and use it in a cell phone to transmit it wirelessly.

Hand-held gaming devices equipped with mini drives can also be an ideal means of distributing games for hand-held gaming devices at lower costs. There is an additional possibility of updating games via the Internet, saving the new version on a mini-cartridge and then using it in a hand-held game player.

GPS (global positioning systems) using a mini drive can download maps from the Internet, or a local map on a mini-cartridge can be purchased for use in a GPS system, while hiking or in a car equipped with a GPS device.

A PDA (personal digital assistant) with a mini drive is an affordable storage technology for PC companions and hand-held devices. They also serve as a high-capacity, affordable means to save and move applications to/from a PC and PDA.

The present invention is designed to provide high capacity at a low cost for hand-held devices. The foregoing and other objects, features and advantages of the invention will be better understood from the following more detailed description and appending claims.

SHORT DESCRIPTION OF THE DRAWINGS

The foregoing summary, as well as the following detailed description of the preferred embodiments, is better understood when read in conjunction with the appended drawings. For the purpose of illustrating the invention, there is shown in the drawings embodiments that are presently preferred, it being understood, however, that the invention is not limited to the specific methods and instrumentalities disclosed. In the drawings:

FIG. 1 is a diagram of the interchangeable mini-cartridge of the present invention, including a plurality of devices each having a mini disk drive, and including a caddy to adapt the mini-cartridge to a full-size drive of a host computer;

FIG. 2A shows a top view of the mini-cartridge with the shutter retracted exposing a magnetic medium;

FIG. 2B shows a bottom view of the mini-cartridge with the shutter retracted exposing the magnetic medium;

FIG. 2C shows a top view of the magnetic medium;

FIG. 3A shows the mini-cartridge seated in the mini disk drive with the read/write heads retracted;

FIG. 3B shows the mini disk de without the mini-cartridge;

FIG. 4A, FIG. 4B, FIG. 4C and FIG. 4D show the mini-cartridge at progressive stages of insertion into the mini disk drive;

FIG. 4E shows the mini-cartridge fully translated horizontally into the mini disk drive in an elevated, unseated position;

FIG. 4F shows the mini-cartridge seated in operational position in the mini disk drive with the ads engaging the magnetic medium;

FIG. 5 shows the top of the mini disk drive exterior;

FIG. 6A shows the male camming surface and the cartridge lock fully seated into the female camming surface and the cartridge lock mating surface, respectively;

FIG. 6B shows the sled tab engagement with the eject tab;

FIG. 7A shows a top perspective view of the caddy without a mini-cartridge;

FIG. 7B shows a top perspective view of the caddy with a mini-cartridge inserted; and

FIG. 8 shows the interface between the full-size drive and the host computer.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a plurality of devices 10–15 which generate signals representing different functions performed by different classes of the devices. For example, the global positioning system 10 can generate signals representing navigational position. Electronic book 11, digital camera 12, personal digital assistant (PDA/Palmtop) 13, portable game 14, cellular phone 15, and laptop computer 16 each generate signals representing the function performed by that particular device.

In accordance with the present invention, each of these devices has a mini drive 20 for writing the signals and reading the signals from a magnetic recording medium so that diverse functions performed by different classes are recorded on the devices. Each device has a mini drive 20, i.e. a mini drive 20*f* for the global positioning system 10, a mini drive 20*g* for the electronic book 11, a mini drive 20*a* for the digital camera 12, a mini drive 20*b* for the portable game 13, a mini drive 20*c* for the PDA/palmtop 14, a mini drive 20*d* for the cellular phone 15 and a mini drive 20*e* for the laptop computer 16.

A mini-cartridge 30 has a magnetic recording medium on which the signals from the devices are recorded. The mini-cartridge 30 is compatible with the mini drives 20. Standard file formats maintain compatibility between devices. In the preferred embodiment, mini drives 20 have a PCMCIA type 3 form factor. This form factor is commonly used in portable personal computers. For example, this form factor could be used for the modem port of a notebook computer. The PCMCIA type 3 form factor is quite small so the mini drive 20 readily fits into all of the portable, hand-held devices shown in FIG. 1. The mini-drive 20 is insertable into and removable from the device just as the PCMCIA modem is insertable into and removable from the PCMCIA slot of a notebook computer. Alternatively, the drive 20 could be hard wired into the device. In both cases, the device generates a digital function signal which is connected to the magnetic heads of the drive so that the digital function signal can be written on the magnetic medium of the mini-cartridge 30. As an example, a digital function signal representing a picture taken in a digital camera 12 is recorded on a mini-cartridge 30. This digital function signal can be read by other classes of devices when the cartridge 30 is inserted into other devices.

Referring to FIGS. 2A and 2B a mini-cartridge 30 in accordance with the present invention is depicted. FIG. 2A presents an isometric top view of mini-cartridge 30, and FIG. 2B presents an isometric bottom view of mini-cartridge 30. Mini-cartridge 30 is fabricated from a magnetic medium 29 disposed between a top shell portion 41 and a bottom shell portion 34. Top shell portion 41 has four integrally formed pads 42, one at each corner. Bottom shell portion 34 attaches to top shell portion 41 within pads 42 and is formed from a substantially rigid materially, such as sheet steel. Both the top shell portion 41 and the bottom shell portion 34 have cut-outs such that aperture 60 is formed in one end of cartridge 30 when the shell halves are brought together.

Shutter 39 is connected over the aperture end of the mini-cartridge 30 to close the aperture and protect the magnetic medium 29 whenever cartridge 30 is outside of a mini drive 20. As such, shutter 39 slides to a first position indicated by line B, revealing magnetic media 29, and slides to a second position indicated by line A, closing the aperture and protecting magnetic media 29 from contamination and the like. When shutter 39 is closed (i.e., moved to the position as indicated by line A), shutter latch 62 engages the slot 64 and locks shutter 39 in place. Thus, in order to move shutter 39 to the open (B) position, the latch 62 must first be depressed to unlock shutter 39. Four cam openings 59 are formed through the corresponding pads 42 of the top shell portion 41 and two cartridge lock cut-outs 57 are also formed in the top shell. Additionally, the top shell portion 41 has a through hole to allow a thinner mini-cartridge 30 while accommodating a drive spindle (not shown). As such, a seal 36, made of substantially thinner material than the material used to form top shell portion 41, is attached to the shell to cover the hole. Magnetic medium 29, as indicated by the dashed line in FIGS. 2A and 2B, is sandwiched between the shell portions 41, 34 and is allowed to float unattached to either shell portion.

Magnetic medium 29 is best described with reference to FIG. 2C. As shown, magnetic medium 29 is substantially circular in shape. Additionally, medium 29 is made from a single piece of flexible material, such as Mylar. As is well-known in the floppy disk arts, a magnetic coating is placed over both sides of the Mylar, making it susceptible to storing data in the form of magnetically readable and erasable signals. A circular hub 32 is attached to the medium 29 and provides the mechanism for connecting the magnetic medium 29 to the drive spindle. Hub 32 is stamped from a single piece of ferrous material, such as sheet steel, forming circular lip 32*a*. Hub 32 and magnetic medium 29 are permanently bonded together with a hot melt adhesive, such as bynel adhesive resin manufactured by DuPont Corp.

FIGS. 3A and 3B show a mini drive 20 with the top cover removed. FIG. 3A shows the mini drive with a mini-cartridge 30 inserted and in an operating position in the drive. FIG. 3B, by contrast, shows mini drive 20 without a cartridge 30, revealing many of the internal drive components. Toward the back portion of the drive, a voice coil actuator 40 is coupled to drive platform 37. Actuator 40 has two arms 42*a* and 42*b* that move linearly in the X axis direction in response to an electrical signal. A read/write head (not shown) is coupled to the distal end of each arm 42*a*, 42*b*. Thus, when a mini-cartridge 30 is inserted into the drive (as shown in FIG. 3A), the heads in conjunction with arms 42*a*, 42*b* move over the surface of magnetic medium 29 reading and writing data.

The remaining internal components are best described with reference to FIG. 3B. As shown, spindle 49 is disposed toward the front of the drive platform 37 and is centered about the width (i.e. the Y axis) of drive platform 37. As with many disk drive spindles, spindle 49 provides the rotational interface between the mini disk drive 20 and the magnetic medium 29. As such, spindle 49 has an alignment pin 49*a* that engages the center of hub 32, ensuring a consistent alignment of the medium 29 in the mini disk drive 20. Additionally, spindle 49 has a magnetic top surface 49*b* that magnetically couples hub 32 to spindle 49. To derive its rotational force, spindle 49 is fixed to the drive motor rotor 50. Thus as the motor (only rotor portion shown) provides the rotational force to the motor rotor 50, spindle 49 also rotates, causing inserted magnetic medium 29 to rotate.

Motor rotor 50 is magnetically coupled to the motor, which is a bushing type pancake motor. That is, motor rotor 50 can be removed from the motor merely by overcoming the magnetic force that holds the motor rotor to its associated motor. Moreover, as stated above, mini-cartridge 30 is magnetically coupled to spindle 49. As a result, removal of mini-cartridge 30 from the drive 20 could cause motor rotor 50 to lift from the motor before the mini-cartridge 30 decouples from spindle 49. Motor hold-down wings 48, coupled to platform 37, prevent motor rotor decoupling. Accordingly, hold-down wings 48 overhang motor rotor 50. Clearance is provided between the overhanging hold-down wings 48 and the motor rotor 50 to allow motor rotor 50 to spin freely during normal operation. When a mini cartridge 30 is ejected from drive 20, hold-down wings 48 will hold motor rotor 50 while hub 32 separates from spindle 49.

A load/eject sled 45 is slidably disposed on drive platform 37 to facilitate cartridge loading and ejection in cooperation with other drive components. Cams 58 are attached to or, alternatively, integrally formed with, load/eject sled 45. The entire sled 45, in tandem with cams 58, slides on drive platform 37 in a direction substantially parallel to the X axis. Initially in a no-cartridge condition, sled 45 and cams 58 are in the proximate position indicated by the line C. After a mini-cartridge 30 is inserted, sled 45 and cams 58 move to a proximate position indicated by line D. During cartridge 30 ejection, eject button 46 is pushed by a user and, as a result of the force supplied by the user, moves sled 45 from a position proximate to the line indicated by D to a position proximate to the line indicated by C. Accordingly, cams 58 are likewise forced to move to the position proximate to the line indicated by C. As is described more fully below, this movement of cams 58 causes a mini-cartridge 30 to eject from the drive 20. Additionally, as is described more fully below, cartridge locks 56 are fixed on both sides of the drive platform 37 and are used to engage and lock a mini-cartridge 30 to drive platform 37 during the cartridge insertion process. These cartridge locks 56 cooperate with cams 58 to provide cartridge 30 insertion and ejection.

A head protect lever 52 is pivotally mounted at its proximate end to drive platform 37 and secures the read/write heads when no cartridge is in the drive 20. Pivot pin 54 is connected to the proximate end of head protect lever 52 and rides in head release slot 51 of load/eject sled 45. When no cartridge 30 is in the drive, head release slot 51 allows a spring to actuate head protect lever 52 rearwardly via pivot pin 54. As a result, arms 42 are retracted. On the other hand, when a cartridge 30 is inserted into drive 20, head release slot 51 forces head protect lever 52 forward, releasing arms 42 and enabling them to move over medium 29.

A cartridge eject lever 47 is pivotally mounted proximately in the back of the drive platform 37 in front of actuator 40. As is described more fully below, lever 47 provides two functions: Opening shutter 39 during cartridge 30 insertion; and ejecting cartridge 30 during cartridge ejection.

The insertion of a mini-cartridge 30 into mini drive 20 is best described with reference to FIGS. 4A through 4F and 5. Starting with FIG. 4A, a mini-cartridge 30 is outside of drive 20 (with the cover and front panel removed for clarity) prior to insertion. At that moment, cams 58 are proximate to the position indicated by line C. Head protect lever 52 has arms 42 in a retracted position. Eject lever 47 is biased in a counter-clockwise position. And, sled 45 is locked into the position proximate to line C, via eject lever tab 47 engaging sled tab 53, and spring loaded by sled spring 66 (best viewed in FIG. 3B).

Referring now to FIG. 4B, as mini-cartridge 30 enters drive 20, it rides along the top of the forward set of male cams 58*c*, 58*d*. Front female cam openings 59*a*, 59*b* in mini-cartridge 30 are sized and located such that they do not match-up with the first set of male cams 58*c*, 58*d* encountered by the mini-cartridge 30. As a result, male cams 58*c*, 58*d* lift cartridge 30, ensuring that it enters above and clears spindle 49 during mini-cartridge 30 insertion into drive 20.

Referring next to FIG. 4C, as mini-cartridge 30 enters further into drive 20, nose 47*a* of eject lever 47 enters shutter slot 64 and contacts the mini-cartridge shutter latch 62. As mini-cartridge 30 is urged yet further into drive 20, eject lever 47 pivots clockwise and moves shutter 39 away from media aperture 60, exposing the magnetic medium 29 disposed within the mini-cartridge shell. Meanwhile, spring 43 provides a counter-clockwise bias on eject lever 47. Thus, simultaneous to eject lever 47 opening shutter 39, eject lever 47 is spring loaded. Additionally, as eject lever is rotated clockwise, eject lever tab 47*a*, which is integrally formed with eject lever 47, also begins to rotate clockwise.

FIG. 4D shows mini-cartridge 30 in the most forward position in drive 20. At that moment, shutter 39 is fully open

and eject lever 47 is pivoted fully clockwise and loaded against spring 43. However, cartridge 30 is not yet seated on spindle 49 and head protect lever 52 has not yet released the heads. Eject lever tab 47*a* is now fully rotated clockwise, away from sled tab 53 (see FIG. 6B for best view of eject lever tab 47*a* and sled tab 53 engagement).

FIG. 4E shows the release of sled 45 and forward movement of sled 45. After the eject lever tab 47*a* has moved away from sled tab 53. The sled is free to move from a position proximate to line C to a position proximate to line D. With the sled now free, spring 66 provides the bias to move sled 45 accordingly. As a result of the sled movement, cams 58 are moved to the D position, providing proper alignment with corresponding cam openings 59 and head protect slot 51 moves forward engaging pin 54 and releasing head protect lever 52.

FIG. 5 in conjunction with FIG. 4F, illustrates the final mini-cartridge 30 loading step. Referring first to FIG. 5, cantilever springs 55 are shown extending downwardly from drive cover 22. These cantilever springs 55, force mini-cartridge 30 down as cartridge 30 fully enters drive 20. However, cartridge 30 is forced by cams 58 to a raised position until cam openings 59 on the mini-cartridge 30 are properly aligned with the matching male cams 58 on the sled 45. At that moment, the cantilever springs 55 urge mini-cartridge 30 downwardly onto male cams 58, as shown in FIG. 4F. Substantially simultaneous to the cam engagement, drive spindle 49 enters the corresponding circular lip 32*a* on the mini-cartridge 30 and magnetically engages hub 32.

According to an aspect of the invention, wedge locks 56 engage the corresponding wedge cut-outs 57 on the mini-cartridge shell. FIG. 6A provides an expanded view of the interlocking of wedge 56*b* with cut-out 57*b* in cartridge 30. Wedges 56 provide a ramped surface on their front side and an acute angled surface on their back sides. The angled surface, as indicated by the angle α, is about 80° in the present embodiment. However, those skilled in the art will recognize that other angles could be substituted for 80 degrees while still providing satisfactory results. Eject lever 47 (shown in FIG. 4F) applies a translational bias to cartridge 30, urging cartridge 30 outwardly. As a result, wedges 56 in cooperation with eject lever 47 lock cartridge 30 into place in drive 20. Mini-cartridge 30 is now ready for access by the read/write heads.

When a user desires to eject a cartridge 30 from the drive, the process is substantially reversed. The user begins by pushing the eject button 46. The force of this action causes cams 58 to move from their location proximate to the line indicated by D toward a point proximate to the line indicated by C. As best understood in conjunction with FIG. 6A, such lateral translation causes cams 58 to engage the corresponding female cammed surfaces 59. As cams 58 move further toward a position proximate to the D line, cartridge 30 begins to lift vertically from drive 20 (in the Z axis direction). When cams 58 are moved substantially to the D line, the bottom of cartridge 30 lifts above the top of spindle 49 and the top of wedges 56. Simultaneously, sled tab 53 is also moved toward the rear of the drive once sled 45 has moved to a position A. At that moment, spring 43 pivots the eject lever 47 counterclockwise, simultaneously ejecting the cartridge 30 and closing shutter 39.

In order to provide forward compatibility to the host computer 23, a caddy 31 is provided. Caddy 31 adapts the mini-cartridge 23 to a full size drive 33. The full size drive 25 is the aforementioned ZIP drive which is disclosed and claimed in U.S. Pat. No. 5,530,607, entitled "WING ATTACHMENT FOR HEAD LOAD/UNLOAD IN A DATA STORAGE DEVICE" by Jay Spendlove on Jun. 25, 1996 and U.S. Pat. No. 5,508,864 entitled "FLEXURES WHICH REDUCE FRICTION IN AN ACTUATOR FOR DATA STORAGE DEVICE" by John Briggs granted on Apr. 16, 1996 and in U.S. Applications Ser. No. 08/398,576 filed Mar. 3, 1995 entitled "HEAD PARK MECHANISM IN A DATA STORAGE DEVICE FOR PREVENTING ACCIDENTAL DAMAGE" by David Jones and U.S. patent application Ser. No. 08/398,576 filed Mar. 3, 1995 entitled "Movable Internal Platform for a Disk Drive." These applications are incorporated herein by reference.

Obviously, a mini-cartridge 30 and a full-size cartridge have a number of differences that prevent the mini-cartridge from directly operating in a full-size drive. Perhaps, the most obvious of these differences is size. Mini-cartridge 30 has a much smaller form factor than a full-size drive cartridge. Whereas, a mini-cartridge is about 1⅞" square and about ⅒" high, a full size drive cartridge is about 3⅞" square and ¼" high. Other differences between the cartridges and the drives also require adaptation to enable a mini-cartridge 30 to operate in a full-size drive. For example, the mini-cartridge rotates slightly faster than the rotation rate of a full size drive cartridge (e.g., 3267 rpms versus 2960 rpms for a full-size drive cartridge). Caddy 31, described more fully below, accepts a mini-cartridge 30 and adapts it for use in a full-size drive.

Referring to FIGS. 7A and 7B, a presently preferred embodiment of caddy 31 is presented. FIG. 7A shows caddy 31 without a mini-cartridge 30, revealing the internal components of caddy 31. FIG. 7B shows caddy 31 with a mini-cartridge 30 snapped into place. As is best shown in FIG. 7A, caddy 31 comprises a caddy body 70 for carrying and adapting the mini-cartridge form factor to the full-size form factor, a drive mechanism 72, 74, 76 for translating power from the full-size drive axis of rotation to the mini-cartridge axis of rotation, a spindle 78 for rotating mini-cartridge 30, and a gear cover 86 for securing main gear 72.

Caddy body 70 is shaped and sized to substantially the same dimensions as a full-size ZIP cartridge and has special features added to adapt a mini-cartridge 30. A depression 81 is formed in the top of caddy body 70. Depression 81 has a rectangular footprint for accepting a mini cartridge 30, and has an adjacent rectangular depression 84 to provide space for the insertion of main gear 72. A cover 86 is disposed overtop depression 84 for holding main gear 72 in place, while allowing gear 72 to adjust to the full-size drive spindle. The depth of depression 81 is such that magnetic medium 29 is disposed at about half the height of caddy body 70, thereby aligning the medium 29 with the height requirements of the full-size medium. Caddy body 70 also includes a lower depression 85. Depression 85 provides space for the drive mechanism 72, 74, 76 to reside below the space occupied by mini-cartridge 30 and provides an opening for the lower full-size drive read/write head to enter the caddy 31 and access magnetic medium 29.

The drive mechanism 72, 74, 76 translates power from the full-size drive motor and spindle to spindle 78 for rotating a mini-cartridge 30 placed in caddy 31. Main gear 72 emulates a full-size cartridge hub and couples to the full-size drive spindle. As such, main gear 72 floats, as does a full-size cartridge hub, and adjusts its location to engage the full-size drive spindle. Thus, when caddy 31 is inserted into a full-size drive, the full-size drive spindle engages main gear 72 as if gear 72 were a full-size drive hub and the caddy were a full-size cartridge. As such, main gear 72 is formed of a ferrous material, or employs a ferrous material, to allow

magnetic coupling with the full-size drive spindle. As the full-size spindle rotates main gear 72, power is provided to the entire drive mechanism of caddy 31.

Gears 74 and 76 translate power from main gear 72 to spindle 78. Gears 74 and 76 are rotatably coupled to caddy body 70 by conventional methods, such as metal or plastic pins. Spindle 78 is fixed to spindle gear 76 such that when gear 76 rotates, spindle 78 also rotates. Furthermore, the center axes of spindle 78 and spindle gear 76 are coincident, ensuring that a stable axis of rotation is provided to a mini-cartridge 30 inserted into caddy 31. Spindle 78 is located within the caddy body 70 such that it engages magnetic medium 29 (see FIG. 7B) at the appropriate height and plane (i.e., on the same plane as media for a full-size drive). Furthermore, spindle 78 emulates the spindle of a mini-drive 20 in engaging a mini-cartridge 30. That is, spindle 78 magnetically couples with hub 32 of a mini-cartridge 30 inserted into caddy 31.

During operation, main gear 72 rotates clockwise in accordance with the rotation of the full-size drive motor. Obviously, spindle 78 must also rotate clockwise so that medium 29 rotates properly in the full-size drive. Accordingly, intermediate gear 74, is coupled between gear 72 and gear 76. As gear 72 rotates clockwise, gear 74 rotates counter-clockwise, causing gear 76 and spindle 78 to also rotate clockwise. Furthermore, as noted above, medium 29 of mini-cartridge 30 rotates within a mini drive 20 at the same angular rotation as a full-size cartridge medium rotates within a full-size drive. Because of the obvious size differences, the angular rotation of a mini-cartridge medium 29 translates to a rotational speed that is slightly faster than the rotational speed of a full-size medium. When operating in caddy 31, the same proper rotation speed of a mini-cartridge 30 must be maintained. Accordingly, gear ratios of 72, 74, 76 must be selected such that the magnetic medium 29 rotates at an angular velocity approximately equal to the angular velocity of full-size drive magnetic medium, or about twice the rotational speed.

Additionally, a point on the circumference of the medium 29 farthest from the centroid of the main drive mechanism 72 defines a forward-most point 82. The forward-most point 82 also lies on a center axis 80, which is defined by points where the vertical center axes of the main drive mechanism 72 and of the spindle 78 bisect the plane defined by the medium 29. The spindle 78 is located along the center axis 80 such that the forward-most point 82 of the mini cartridge medium 29 is coincident with a forward most point of a full-size medium of a standard, full-size disk cartridge. Such location of the mini cartridge medium 29 enables the heads of the full-size drive to properly engage the medium 29.

Those skilled in the art will readily appreciate that many modifications to the caddy are possible within the scope of the invention. For example, a belt drive mechanism could be used in place of gears, or additional gears could be used to provide a more stable rotation. Accordingly, the caddy is not limited to the single embodiment disclosed.

The ZIP drive 33 has an interface 24 for transferring signals between the full size drive 33 and the host computer 35. The interface 34 is shown in FIG. 8.

FIG. 8 shows the ZIP drive interface 26 between the read write channel for the disk (lower right side of diagram) and the host computer (upper left side of diagram). It includes an AIC chip 101 which performs the SCSI 102, the DMA 103, and disk formatter 104 functions. The interface also includes a PHAEDRUS 105 which includes an 8032 micro controller 106, a 1K Ram 107 and an ASIC 108. The ZIP interface transfers data between the input/output channel of the ZIP drive and SCSI devices such as the host computer.

Although a particular embodiment of the invention has been shown and described, other embodiments and modifications will occur to those of ordinary skill in the art which fall within the scope of the appended claims.

What is claimed is:

1. An interchangeable cartridge data storage system comprising:

a plurality of devices for generating signals representing different functions performed by different classes of said devices:

a mini-cartridge having a medium on which said signals are recorded; and

a mini drive in said devices for writing said signals and reading said signals from said medium so that diverse functions performed by said different classes of said devices can be interchangeably operated upon by said devices.

2. The data storage system recited in claim 1 further comprising;

a full size drive larger than said mini drive and accommodating a cartridge which is larger than said mini-cartridge; and

means for adapting said mini-cartridge to said full size drive to make said devices forward compatible with said full size drive.

3. The data storage system recited in claim 2 further comprising:

a host computer, said full size drive having an interface for transferring signals between said full size drive and said host computer.

4. The data storage system recited in claim 2 where said full size drive accommodates a full size cartridge and wherein said full size cartridge has a recording medium on which said signals are recorded and from which said signals can reproduced.

5. The data storage system recited in claim 4 wherein said medium in said mini-cartridge and said medium in said full size cartridge are a flexible magnetic disks.

6. The data storage system recited in claim 2 further comprising;

a caddy for accommodating said mini-cartridge to make it compatible with said full size disk drive.

7. The data storage system recited in claim 6, wherein said full size drive has a spindle motor and wherein said caddy has means for translating the center of rotations of said spindle motor to a different center of rotation of said mini-cartridge.

8. The data storage system recited in claim 7 wherein said caddy has means for changing rotational speed from a lower rotation speed of said full size cartridge to a higher rotational speed of said mini-cartridge.

9. The data storage system recited in claim 1 wherein said different classes of devices include digital cameras, electronic books, global positioning systems, personal digital systems, portable games, cellular phones and digital cameras.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,809,520

DATED : September 15, 1998

INVENTOR(S) : Kim B. Edwards et al

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Col. 3, line 29, "de" should be --drive--.

Col. 3, line 38, "ads" should be --heads-.

Signed and Sealed this

Twenty-ninth Day of December, 1998

Attest:

Bruce Lehman

BRUCE LEHMAN

Attesting Officer

Commissioner of Patents and Trademarks